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SUBJECT: HYDROSOL: AN OPPORTUNITY TO COLLABORATE WITH GERMANY ON HYDROGEN

¶1. (U) Summary and Comment: The German Space Agency (DLR) has, in conjunction with the International Energy Agency's solar-thermal energy cooperative "SolarPACES", developed an efficient carbon dioxide (CO2)-free method of harvesting hydrogen from water. Named "HYDROSOL", this is an interesting innovation that could bridge key challenges in support of USG efforts to develop a hydrogen economy. Although the HYDROSOL project is only one of many worldwide efforts (including at Sandia National Laboratories) to harvest hydrogen, it appears to stand apart from the rest with its impressive demonstrated efficiency and absence of CO2 emissions or harsh chemical byproducts. The HYDROSOL concept has since evolved into the HYDROSOL-2 project and recent agreements have opened the door for U.S. companies to collaborate. This award-winning technology was recognized by the International Partnership for the Hydrogen Economy (IPHE--of which the U.S. is a partner) in 2006 for its significant potential for large-scale, sustainable, emissions free hydrogen production. If the relevant US-EU intellectual property concerns can be resolved, HYDROSOL-2 may offer US researchers working on hydrogen an opportunity to collaborate with Germany on a promising new technology. End Summary and Comment.

HOW IT WORKS: SEPARATING WATER WITH SUNLIGHT

¶2. (U) HYDROSOL uses a two-stage thermochemical process that first releases hydrogen from water by adsorbing the oxygen into an oxygen-deficient ferrite structure (the reactor core) at superheated temperatures. When the reactor core is saturated with oxygen, additional energy is provided and the oxygen is re-released. The catalytic energy for these two reactions is derived entirely from concentrated solar radiation. Using two identical reactor cores housed in separate chambers of a solar concentrator, the two stages are operated simultaneously (i.e. while one reactor core is adsorbing oxygen from water, the other is depleting its oxygen). The functions of the two reactor cores are continuously swapped, ensuring that hydrogen is produced continuously and not in batches. According to project coordinator Athanasios Konstandopoulos, Director of the Chemical Processes Engineering Research Institute/CERTH based in Thessaloniki, Greece, each HYDROSOL-2 reactor will produce around three kilograms of hydrogen per hour; at hydrogen's energy density, this is theoretically equivalent to a power output of 119 kilowatt-hours.

HYDROSOL BACKGROUND: AWARDS, BUT IPR CONCERNS WITH U.S.

¶3. (SBU) By April 2008, the entire HYDROSOL project had

spent seven million euros, half of which came from the European Union's 5th and 6th European Research Framework Programs. According to Christian Sattler, DLR Research Area Manager for Solar Materials Conversion, the USG was not invited as a project partner due to concerns about intellectual property (IP) rights between the E.U. and U.S. The HYDROSOL consortium currently includes research teams from Germany, Spain, and Greece, as well as industrial partners Johnson Matthey Fuel Cells (UK) and Stobbe Tech Ceramics (Denmark). The project won the European Commission's 2006 Descartes Prize for scientific research, the 2005 International Global 100 Ecotech Award at the EXPO in Japan, and the IPHE Technical Achievement Award in 2006.

COST ANALYSIS: PRICE COMPETITIVE WITH OIL?

¶4. (SBU) According to Sattler, a DLR model (reportedly validated by the US Department of Energy--DOE) predicts that it will cost between two and five dollars to produce one kg of hydrogen (using scaled HYDROSOL technology), correlating with an equivalent energy value of $40 to $100 per barrel of oil. (Comment: These calculations do not include costs associated with the transportation or storage of hydrogen, which could be enormous. End Comment) Sattler noted that the dominant cost for the HYDROSOL project is the establishment of the infrastructure for a large scale operation. He added that once the infrastructure investment is made, the longer the reactor runs and the more economically viable it becomes.

SIMILAR RESEARCH IN THE U.S.

¶5. (SBU) The U.S. has also conducted a substantial amount of research in the area of thermochemical production of hydrogen from water with a variety of catalytic processes. Similar in concept to the HYDROSOL reactor, researchers at Sandia National Laboratories in New Mexico designed a reactor that uses cobalt ferrite rings as the catalyst. Presently, Sandia researchers have embarked on a project called "Sunshine to Petrol", which utilizes the aforementioned reactor design to synthetically produce methanol (a hydrocarbon used for transportation fuel). Like HYDROSOL, this reactor design is used to harvest hydrogen. However, in a parallel process it also removes oxygen from carbon dioxide to collect carbon monoxide. The harvested carbon monoxide and hydrogen are then synthesized together using industrial processes to create methanol. The aim of this project is to produce methanol as a fuel in a nearly carbon neutral fashion.

THE ROAD FORWARD

¶6. (SBU) Given the parallel advances in CO2-free hydrogen harvesting techniques demonstrated by Sandia National Laboratories and the HYDROSOL project, it appears as though there may be room for future technical exchange or cooperation. Sattler said improvements in scientific research exchanges between the U.S. and E.U. have opened the door for HYDROSOL cooperation with many U.S. companies. According to Sattler, a big reason for this is the IPHE, coordinated by Professor Al Weimer of the University of Colorado (Boulder), which DLR joined in 2005. Sattler said DLR continues to investigate ways to foster collaboration with the U.S. DOE and specifically mentioned the SolarPACES group as an excellent avenue for future collaboration.
TIMKEN JR